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LARGE-SCALE SYSTEM DIRECTIONS

FOR DISK, TAPE, AND PRINTER SYSTEMS

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LARGE-SCALE SYSTEM DIRECTIONS FOR DISK, TAPE, AND PRINTER SYSTEMS

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I INTRODUCTION

A. RESIDUAL-VALUE FORECASTING

- INPUT has been forecasting detailed residual values for IBM and software-compatible mainframes since 1977 and for selected peripheral products since 1979. The emphasis of the Residual Value Forecasting Series has always been upon analysis and anticipation of significant product development and pricing strategies rather than mere reporting of used-market prices.

- During this period ~~of time,~~ fundamental changes have occurred in ~~both~~ the computer market ~~environment for computer products~~ and the technologies upon which systems are ~~being developed~~. The two dominant ~~factors in these~~ changes are:

  - IBM, demonstrating remarkable flexibility, has transformed itself from a business machines manufacturer into a global force for post-industrial change. ~~As such,~~ it is the most powerful private enterprise the world has ever known, and it will exercise more influence over the development of the information age than will any other single organization - public or private. In fact, it is not unrealistic to say that IBM will create the information age to satisfy its growth requirements.

  - Just as IBM dominates the market environment, the microprocessor dominates the technological scene. Just as early computers rapidly exceeded the total manual and electromechanical processing capability of the entire world, so ~~the~~ microprocessors have exceeded large-scale systems. There is already more processing power (MIPS) installed on

microprocessors than on large mainframes, and the gap is widening exponentially.

- It is obvious that both of these changes will become increasingly important in determining the residual values of large-scale systems, and INPUT explored some of the ramifications of IBM's market dominance in Residual Value Forecasts: Fall Update, November 1983. However, it is also necessary to stand back and take a look at overall large-scale systems directions in light of the microprocessor revolution.

B. LARGE-SCALE SYSTEMS DIRECTIONS

- INPUT has decided that a macro view of large-scale systems directions may be more important in protecting ~~your~~ investment in information systems than are the residual values of individual products. Therefore, starting with this report, the title of the series will be changed to Large-Scale System Directions, and residual values will be included as part of that series.

- This change of title does not reflect decreased emphasis on residual-value forecasting. It represents an expansion of trend analysis ~~which we~~ that INPUT believes is necessary to put individual systems components into proper perspective. The objective will be to provide an understandable overview of market and technological trends suitable for ~~both~~ systems and financial planners.

- In Chapter II this report provides a systems overview of directions in disk, tape, and printer technologies ~~which~~ that stresses ~~their~~ interactions and the potential impact of new technology. Specifically, the report will emphasize:

  - The general trend in the demand for on-line storage.

  - The impact of IBM data base directions on storage requirements in a distributed data base environment.

- The potential impact of micro/mainframe links on storage requirements.

- The significance of optical memory developments.

o In Chapter III the projected residual values of selected IBM disk, tape, and printer systems will be updated. The products covered in this report are the model series 3350 and 3380 disk drives, model series 3420 tape drives, and printer models 1403 N1, 3211, and 3800. These forecasts represent updates of those presented in Residual Value Forecasts for IBM Disk, Tape, and Printer Systems, March 1983, and that report is recommended as a "lead-in" reference document for background on INPUT's analysis of IBM peripheral products and their residual values.

II

II A SYSTEMS VIEW OF DIRECTIONS IN DISK, TAPE, AND PRINTER TECHNOLOGY

A. DEMAND FOR ON-LINE STORAGE

1. GENERAL TREND

- It is important to recognize that disk, tape, and printer systems actually represent a single storage hierarchy ~~which~~ that is dictated by cost and access requirements. Theoretically, all data and information could be kept on-line (with immediate access) if relative costs were not a consideration.

  - Tape systems used for high-volume data collection, backup of disk storage, archival storage for low-access data, etc., could be replaced with on-line storage if such storage was cost competitive.

  - High-speed printer systems, such as those covered in this report, produce enormous amounts of paper which of necessity contains relatively low- (and slow-) access data and information. After relatively short active use (or perhaps no use), paper documents ~~(or reports)~~ are either discarded or filed for even more limited access.

- Because both tape and paper media require physical handling, there is a ~~potential~~ potentially fundamental cost advantage in having all data and information on-line. Improvements in magnetic disk technology have proceeded on a

predictable cost-per-bit declining curve (based on area densities) for the last two decades. This has resulted in cost differentials shifting in favor of disk storage for an increasing applications set and this has translated into increased demand for magnetic disk storage systems, and ~~also in~~ relatively predictable cycles of obsolescence for such systems. There are indications that this relatively orderly progression is going to be severely ~~impacted~~ affected during the remainder of this decade by technological advances in optical memory systems.

- The cost of conventional magnetic disk storage is reaching a critical cross-over point where it will become cheaper than the true cost of paper storage. The true cost of paper storage ~~being that of~~ includes printing, supplies, handling (~~including~~ filing and retrieving), file cabinets, office space, etc. As ~~the~~ an awareness of these true costs becomes more prevalent, the demand for on-line storage will increase sharply (rather than stabilize as projected by many who consider current demands for disk storage abnormal).

- It is also anticipated that the orderly progression of magnetic disk area densities (and therefore costs) will be disrupted by the availability of optical disk systems with suddenly increased densities and decreased cost ~~characteristics~~. These will open up ~~vast~~ many new applications ~~as are~~ in document storage and image processing - indeed, in all communications including audio and video.

(A) These improved optical disk systems...

o Even with dramatic improvements in on-line storage costs, this increased demand for on-line storage is going to result in an increasing proportion of the data processing budget being spent for on-line storage facilities as compared to mainframes, minicomputers, and peripherals (such as tape systems and printers). In addition, it is probable that projected revenues from on-line storage are more critical to IBM's strategic plan than are PC-based intelligent workstations. In fact, a good argument can be made that the proliferation of intelligent workstations will fuel the demand for on-line storage at all levels in the SNA hierarchy.

- A brief look at IBM data base software directions and the current fascination with micro-mainframe links will demonstrate the ~~logic behind this~~ basis for assertion.

2. SOFTWARE IMPACT

- IBM announced DB2 (a relational data base management system) for MVS/XA, VM/XA and MVS/370 architectures in June of 1983. It also provided the ability to extract operational data and build relational tables. The general architecture of DB2 is presented in Exhibit II-1.

  - Data Extract (DXT) extracts "selected operational data" from: 1) physical sequential files; 2) VSAM data sets; and 3) IMS/VS or DL/I data bases and prepares them for loading into DB2 tables (data bases).

  - Access to the extract facilities under MVS can be through IBM/VS data communications, CICS/OS/VS, TSO and batch processing; ~~and~~, of course, relational data bases can be constructed using the facilities of DB2 itself.

  - Once the DB2 relational tables (data bases) have been built, the Query Management Facility (QMF) allows users to extract, manipulate, and generate interactively reports from the relational data base.

- The general systems architecture was designed for programmers and users to facilitate the extraction of data from existing files and provide the flexibility and ease-of-use ~~which~~ are inherent in relational systems. Such facilities are very appealing, but the ramifications for on-line storage seem clear:

  - First of all, the limit of 64 gigabytes on relational tables does not represent small thinking on the part of the systems designers; and it may be prophetic.

- It should also be pointed out that even the developers of the relational data model admit that the IBM hierarchical model will be around at least into the next century, and the CODASYL (network) model is certainly not going to go away either. It is clear that the benefits of the relational model will only be gained at the expense of duplicate data bases. The extent of this duplication can only be surmised, but the opening up operational data bases to programmers and users seems to be at the very foundation of the current trends towards systems prototyping and information centers. The relational model has well-documented advantages in such an environment. There is not only the possibility, but the probability, that the extracts from existing data bases will exceed the size of the operational data bases in short order - the only question is ~~how much larger will they grow~~ the point at which growth will stop.

- The ability to extract data from sequential files has the exciting possibility of processing archival tape files and retrieving valuable historical information for planning purposes. The relational data model provides the ability to structure ~~these~~ historical data in a flexible enough manner to be useful, but once again the demand for disk storage could increase dramatically. Indeed, if sequential history files are literally going to be opened up to general use, it might become necessary to keep at least portions of them on-line for ready access.

- The relational tables ~~which~~ that are born from the marriage of historical and operational data will tend to grow up rapidly and beget data bases of their own. ~~The very~~ Both flexibility ~~which~~ that recommends the relational model, and the operators provided to manipulate the tables ~~assure~~ guarantee that unusual relationships will develop ~~(some may border on incestuous)~~, and that some of the offspring may tend to be rather unusual. However, they will all have to be housed and that will require more disk storage.

- At the present time, no provision is made (under DB2 or DXT) for extracting from the relational tables and creating hierarchical and/or

network data structures since this is not deemed necessary by relational proponents. However, there will definitely be a tendency for systems developed under the relational model to go into production ~~and~~ a performance considerations may dictate the reverse duplication of data bases (for example, DB2 to IMS) as transaction volumes against relational data bases grow.

o This proliferation of overlapping data bases will contribute substantially to the increased demand for magnetic disk storage ~~which will be~~ presented in Exhibit II-2. The data is

3. MICRO-MAINFRAME IMPACT

o The current rush to link personal computers and micro-based intelligent workstations to mainframes is motivated by providing access to data bases. Practically everyone is in agreement that PC users will need easy-to-use tools and assistance if they are to deal with current data bases. The availability of DB2 later this year will most definitely facilitate the micro-mainframe link, but exactly how IBM will direct its customer base ~~in~~ with regard to micro-mainframe links and local-area networks (LANs) is still open to speculation. However, even a simple scenario will illustrate the enormous demand for the on-line storage ~~which~~ that will be generated. II-2

o Micro-mainframe links are a logical extension of distributed processing, and distributed processing has always implied distributed data bases. It doesn't make much sense to have processing power on every desktop unless there is data available to process. It is our opinion that distributed data bases will eventually evolve into a structure similar to that depicted in Exhibit II-~~2~~3. INPUT'S ~~Our~~ reasoning is as follows: II-2

- As soon as micro-based intelligent workstations are linked to mainframes (using the facilities associated with DB2), the requests for extracts from the host (both as depicted in Exhibit II-1 and through manipulation of the relational tables) will result in the transfer of substantial amounts of data to the intelligent workstations. Initially, this will result in increased demand for hard disk on the workstations, but volumes and transmission requirements will expose the need for

buffering the micro-mainframe links with an intermediate processing and storage level because of:

. The capacity and cost-effectiveness required for host-node communications.

. The storage capacity required for the unanticipated quantities of data which operators (programmers or users) of the intelligent workstations will either knowingly or unknowingly request.

- As micro-mainframe users build personal data bases on either floppies or hard disk, they will soon realize the importance of backing up these files. This will be most economically and conveniently done on the LAN's distributed system.

- The distributed processor on the LAN will therefore experience substantial growth in the demand for on-line storage to buffer requests for host data and to backup personal files from workstations. In fact, the growth will probably cause 43XX processors to be IBM's preferred solution in order to support the management of the storage facility.

- Whether or not the distributed processor is attended or unattended, the need to backup the distributed data bases will soon be recognized and off-site storage on the host will be encouraged by both vendors and central data base administrators. Thus, there will backups of the backup going up the storage hierarchy,

o The opening up of central data bases which is implied by the major trends in the industry - systems prototyping, information centers, relational data bases, and micro-mainframe links - will point to explosive growth in the demand for on-line storage at all levels in the processing hierarchy. Questions of data base integrity and synchronization in such an environment cannot be discussed

with the scope of this report except to state that a major problem is going to exist, but regardless of how well those problems are handled the requirements for on-line storage are going to be substantial.

- Considering the normal increase in operating data base sizes, new applications, the duplication of data bases in a DB2 environment, the backup problems associated with distributed data bases, and requirements for document storage, it is not unreasonable to anticipate on-line storage capacity increasing by 50% per year throughout the 1980s, as shown in Exhibit II-12.

  - This means there will be 17 times the amount of on-line storage installed in 1990 that there was in 1983.

  - Even considering past improvements in the cost of magnetic disk storage (the cost has tended to be cut in half every five years), the cost of on-line storage will be seven times greater in 1990 than it was in 1983.

  - It is our opinion that the growth in on-line storage, which is approximately twice that of IBM's overall growth, figures prominently in IBM's strategic growth plan for the remainder of the 1980s. Therefore, it is in IBM's best interests to control the development, release, and acceptance of new technology which would seriously ~~impact~~ affect the revenues from magnetic disk storage systems. Specifically, IBM must control the acceptance of optical memory systems and their use and application.

B. OPTICAL STORAGE UPDATE

1. POTENTIAL IMPACTS

- In April 1983, INPUT published Impact of Upcoming Optical Memory Systems, which was a comprehensive analysis of optical memory technology, its systems applications, potential impact on current technologies, and its forecasted development. This section will present a limited update of that report.

- The simplest way to illustrate the potential impact of optical memory systems is to plot the projected cost of optical storage against past and current on-line storage systems, as shown in Exhibit II-4.

  - Optical memory costs were projected to be between .0002 (2×10^{-4}) and .00003 (3×10^{-5}) cents per bit in 1984 and declining to between .00001 (1×10^{-5}) and .000001 (1×10^{-6}) by 1986. These costs were also projected to continue downward until they reach 1×10^{-8} cents per bit in the 1990s.

  - It is obvious that these costs destroy not only the orderly pattern of decrease in magnetic disk costs which go back to the IBM 2311 and 2314 approximately 20 years ago, but also the cost-effectiveness of the IBM 3850 Mass Storage System.

a. Magnetic Disk

- The impact of optical memories on magnetic disk systems will initially be limited by the fact that early optical disk systems will not employ erasable media. In other words, once data is recorded on optical disks it cannot be written over and the disk cannot be reused.

- However, there are those who will argue that a high percentage of on-line storage should not be erased and, considering the cost advantages, applications could be restructured to take advantage of the technology. Besides, optical disks have other advantages:

  - A single optical disk platter has more capacity than an IBM 3380 disk drive; double-sided platters having ten times the capacity of the 3380 are projected, and optical disk packs having 100 times the capacity of a 3380 drive have been promised by some vendors for 1984-85 announcement.

  - In addition, optical disk platters are removable so storage is truly unlimited. (The removable platter is also touted to have the capacity to hold the entire Encyclopedia Brittanica including illustrations - the equipment of 500,000 typed pages).

  - For those concerned about floor space now, the anticipated growth in on-line storage of 17 times in the next seven years is far from a trivial problem. The potential advantages of optical disk in such an environment are apparent.

- In addition, as office automation progresses and documents are stored at approximately 300,000-500,000 bits per page, the advantages of optical disks will become even more apparent because even though optical disks may not be erasable the cost of the media (platters) will be less than the cost of the paper which is being replaced.

b. Tape

- The major uses of magnetic tape (disk backup and archival storage) are more likely to be concerned about archival life rather than erasability and consequently reuse. Optical disk has many potential advantages when compared with tape systems.

- Like tape systems, the optical media (disks) are removable and offer unlimited storage. In addition, optical disks are projected to have substantially better archival life (extimated 10 years versus 2-3 for magnetic tape) even though there are those who will say archival life cannot be proven until the ~~media has~~ medium has been around that long.

- Since a single optical platter may hold over 200 times the amount of data of a reel of magnetic tape, the handling and storage costs will be reduced.

- Optical disk permits random access to data (as opposed to serial access on tape) and data transfer rates are better.

o The possibility of keeping ~~large quantities of~~ selected, sequential, historical data on-line using optical disk in the DB2 environment depicted in Exhibit II-1 is intuitively attractive. In fact, optical disk as a magnetic tape replacement in practically all environments appears to be very attractive once the technology is proven.

c. Printer Systems

o To the ~~degree~~ extent that high-speed printer systems are used to produce voluminous reports for reference, active storage, or archival purposes, optical memories have the potential for providing on-line storage with easy access at substantially lower cost. To a large degree computer systems and office copiers have contributed to ~~the~~ today's paper handling problems ~~which exist today.~~ that Optical memories by providing the ability to keep virtually all data and information in manageable (processable) and easily accessable form hold the promise of at last stemming ~~the~~ explosion in paperwork.

o For years it has been stated that people prefer to deal with paper rather than electronic media. Personal computers are in the process of training vast numbers of people in all walks of life to perform a high percentage of their

work without resorting to hard copy. In fact, because of both cost and convenience, paper documents are produced only as a final product and frequently as a last resort (only when information from the screen has to be communicated to someone else). Once reference documents and historical information are on-line, paper will start to disappear from the office environment.

2. ANNOUNCEMENTS AND STATUS

o In 1983 several announcements of significance were made in optical technology and products. It is anticipated that 1984 will see the first installation of optical memory systems in data processing environments (as opposed to electronic filing systems and micrographic replacement systems).

o STC announced an optical disk subsystem capable of storing four billion characters for $130,000. It had the following characteristics:

- It employs nonerasable media.

- Each removable 14" platter contains 32 billion bits (four billion characters) on a single side and sells for ~~between~~ $140-225 per platter depending upon quantity ordered.

- The system is designed to operate off the STC 8880 controller in a mainframe environment and is IBM software compatible (including MVS/XA).

- It is anticipated that systems will be installed this year.

o Optimum (a joint venture of Xerox, Shugart and Thomsen CSF) announced an optical disk drive capable of storing one billion characters for approximately $7,500 (in quantities of 250) including an electronic controller.

Thompson CSF

here's the Right Stuff (I called the Co)

Tim Tyler

494-2884

- the disk drive employs nonerasable media.

- Each side of the removable 12" platter can store eight billion bits (one billion characters).

- The drives are intended primarily for use by systems integrators employing micro- or minicomputers in an office environment.

- Due to the need for systems integration and software development, the drive will probably not be incorporated into a system until 1985.

o Hitachi announced an optical disk drive employing 12" removable platters capable of storing 1.3 billion characters per side. It will not be available in the U.S. until the end of 1984, and no prices for the drive have been quoted. However, single-sided platters are reported to sell for $200 and double-sided ones for $300; they are nonerasable.

o Matsushita caused quite a stir by demonstrating the first erasable optical disk system, but the system is currently only practical for document storage and micrographics replacement where erasability is not terribly important. Announced characteristics include:

- The erasable disks are 8" in diameter, removable, and capable of storing up to 15,000 documents.

- The system is loaded a page at a time through a photographic process, and access to each stored page requires about half a second.

- The price of the unit (presumably including entry and display facilities) is $80,000, and at that price the practical applications are limited.

o The rough cost-per-bit of the STC optical disk subsystem and the Optimum optical disk drive are revealing when compared with Exhibit II-4.

II-4

But the STC optical subsystem

- The cost of the STC optical subsystem is .0004 cents per bit which would place it below the IBM 3380 range (which, depending upon model, is approximately .0005-.0008 cents per bit), but it does not approach even the upper limit of projected 1984 optical memory costs (.0002 cents per bit). STC pricing may be dictated by a combination of having developed a workable subsystem suited for early installation and a sensitivity for the impact on its own magnetic disk business.

- On the other hand, the Optimem optical drive, at .00009 cents per bit, falls easily within the projected range of .0002-.00003 cents per bit. (If the controller is eliminated, the cost of the drive would be .000075 cents per bit which is close to the center of the projected range.)

o Generally speaking, the last year has seen the announcement of products and technology that are in line with the forecasted development of optical memory systems contained in INPUT's April 1983 report, Impact of Upcoming Optical Memory Systems.

3. FORECASTED DEVELOPMENT

o In the optical memory report, INPUT defined seven optical memory systems categories and made three predictions: ~~Categories and predicted~~, 1) when the technology would become available, 2) when IBM would prefer to announce such systems, and 3) when IBM would actually announce such systems. Details are shown in Exhibit II-5.

II-5

o The STC optical subsystem falls into General System Category 5a - it is designed for use with mainframes and has direct-read-after-write capability (DRAW), but the medium is not erasable.

o The Hitachi and Matsushita systems fall into category 2 (Standalone Optical Disk). They are not considered suitable for integration with local area networks or with data processing systems.

- The Optimum optical disk drive is specifically designed to support categories 3 and 4a (Electronic Filing and Retrieval - LAN, and Integrated Image Processing - Basic System). The 4a general system category is the first which integrates optical memory with conventional data processing systems.

- A meaningful way to display the forecasted availability of optical memory systems is against the general systems architectures which were presented in Exhibits II-1 and II-2 of this report. Exhibit II-6 distributes the optical memory systems category over the hierarchical on-line storage architecture, and provides some insight into the availability of optical memory systems to relieve the demands for on-line storage which were projected earlier.

  - Where significant products have been announced the vendors' names have been listed, otherwise the date of anticipated availability is used.

  - Since major impact on magnetic media systems in the data processing industry is unlikely until the traditional IBM endorsement is obtained, the projected dates for IBM product announcements are listed separately.

- Proceeding down the storage hierarchy from mainframe storage facilities the following observations can be made:

  - The announced STC product (category 5a) should be attractive as a replacement for magnetic tape systems in many environments, and also can be used to supplement and complement magnetic disk, where erasability is not an absolute requirement. Acceptance during 1984-85 will probably give IBM incentive to announce a competiting 5a product in 1986.

  - An erasable, category 5b subsystem suitable for host mainframe storage replacement is not anticipated until the late 1980s.

- A category 6 system (Distributed Informations Manager) consists of optical disk packs and jukeboxes capable of storing enormous amounts of information. (A jukebox has been projected to store up to 10^{14} bits of data, which is equivalent to the entire National Archives or two million reels of magnetic tapes, using only 225 square feet of floor space.)

  . At time of announcement STC stated it was working on a jukebox, and Phillips has been talking about one for years.

  . Such systems could hold the contents of entire libraries, and even small ones consisting of four optical disk packs could replace the IBM 3850 mass storage system (3.7×10^{12} storage capacity).

  . It is probable that such systems may be available on a custom basis (fairly expensive) prior to the projected 1988 availability dates.

- Integrated Image Processing Systems (categories 4a and 4b) are ideally suited for office automation where they effectively bring together the ability to store and access a mixture of encoded data from current data base systems with documents and images on an economic basis. As such they are extremely important for the development of advanced office systems and LAN's.

  . Optimum is announcing their product specifically directed it towards document storage and backup (rather than replacement) of magnetic disk storage on micros and minis.

  . Even though it is anticipated that numerous optical disk drives appropriate for category 4 systems will be available, the

problems of systems integration are significant, and category 4a. requires only a gateway from the image system to data processing systems on the same LAN.

. Fully integrated systems ~~which~~ that are relatively transparent to users (in terms of ~~both~~ installation and use) will probably not become generally available before 1988.

. It is in this area that IBM would prefer to maintain current technology during the late 1980's (for purposes of revenue). However, it is probable that support of products ~~such as~~ like the IBM Scanmaster will force the use of optical memories in some restricted areas even prior to the 1986 timeframe projected for category 4a.

- Both commercially available videodisk players like those used for movies (category 1), and standalone optical disks suitable only for document storage (category 2), have already been interfaced to microprocessors including the IBM PC. As micro-mainframe links and LAN's develop, it will become apparent that these systems can be roughly integrated in the office environment, but the impact on storage requirements will be minimal until more advanced systems become available.

- The most logical advance will be towards an Electronic Filing System (category 3), that is connected to the LAN. These systems should become readily available during the 1984-1985 timeframe and should provide a cost-effective alternative to storage of documents (for example from Scanmaster) on magnetic disk.

- Since the developers of optical disk systems (such as Optimum) have announced products for the OEM market, it is possible that someone will use the product for a category 4a. system on an intelligent

terminal in the near future. However, it is doubtful that such systems will become very popular since they would more than double the cost of the workstation. This would put it into the range of the original XEROX STAR ($15,000) and most vendors are very cautious about that market especially since the need (or even desirability) for a gigabyte ~~of~~ storage at the workstation is not currently understood. ~~(Remember, micro-based systems are included under the storage managers at the higher level where category 4 systems will be developed).~~

- Essentially, it is anticipated that the imaginative use of upcoming optical memory systems can have two benefits:

  - They will permit the implementation of advanced office systems more rapidly than could be justified using magnetic storage.

  - They will permit the cost of rapidly increasing demands ~~for on-line storage to be controlled.~~ for the control of on-line storage.

- The potential impact of optical memories on the residual values of disk, tape, and printer systems was mentioned in INPUT's last report on this subject (Residual Value Forecasts for IBM Disk, Tape, and Printer Systems, March 1983). The currently predicted availability of optical memory systems ~~are~~ considered in the residual value forecasts ~~which~~ follow. However, in many ways, optical memories will have ~~impacted~~ effects as substantial as those of personal computers on data processing and office systems. For that reason, continuing analysis of optical technology ~~will be required during the next several years.~~

C. LARGE-SCALE MAGNETIC DISK DIRECTIONS

- Technological directions in large-scale magnetic disk systems have been fairly predictable and have the effect of maintaining the cost-per-bit curve ~~which~~ is presented in Exhibit II-4.

- A double-density 3380 drive is possible in 1984, but a new disk generation is not projected before late 1985.

- The new-generation product will probably incorporate only two ~~of~~ or three possible changes ~~in media which are currently being tested.~~ that are currently being tested. INPUT believes product design specifications can be met by incorporating only the first two of the following:

  - A thinner coating of magnetic material on the base platter.

  - A magnetic particle with greater field strength per given mass than iron oxide.

  - A vertical rather than horizontal orientation of the magnetic particle.

- A major improvement in rotational speed from 3600 rpm up to 6000 rpm is also projected, which along ~~the~~ with higher bit densities will produce transfer rates in the range of 12-15 megabytes per second.

- This new disk generation will be expected to withstand the technological challenge of optical memories through this decade. (A comprehensive review of disk developments was contained in INPUT's residual-value report on peripherals which was published in September of 1982.) Whether or not a new follow-on magnetic disk generation ~~appears on the~~ on the historic five-year cycle in 1990 will depend upon the development and acceptance of optical memory systems.

D. TAPE SYSTEM DIRECTIONS

- Rumors abound concerning the reasons IBM has not announced the new tape generation. INPUT has been projecting since the September 1983 report (see that report for product details). Among the reasons being advanced are: technological problems, reaction to optical memory developments, and just plain marketing strategy.

- Regardless of the reasons, customers who require 20-30 minutes to dump a 3380 unit (even using sophisticated software) are getting very impatient for a new high-speed, large-capacity tape drive. INPUT continues to believe that IBM will respond to these needs soon. (However, this prediction is getting nearly as embarrassing as our classic 3705 replacement predictions which went on for years. Come one, IBM, have a heart.)

E. PRINTING SYSTEMS

- The last Residual Value Forecast of IBM Disk, Tape, and Printer Systems, March 1983, contained a comprehensive analysis of trends in printing systems, a review of current products, and an assessment of IBM's directions with printing systems. There is no replacement technology development activity which currently threatens the 3800 printer system. The potential for higher quality, faster and more cost-effective distributed printing remains the most exciting area which may impact residual values of such large central printing systems (see the report of March 1983 for details).

III

III RESIDUAL VALUE FORECASTS

A. PRICE TREND HISTORY

- Exhibit III-1 presents the price trend history for selected IBM peripherals. Since INPUT's Residual Value Forecast: Fall Update issued in November 1983, the IBM list prices for the 3350-B02 have been reduced by 23% and those for the 3375-B01 have been reduced by 15%. Otherwise the list prices of the selected peripherals remain the same ~~as in that report.~~

- The current (February 1984) list purchase prices for IBM disk products are contained in Exhibit III-2.

- After this report had been prepared, IBM announced the 4248 impact line printer, which is designed as a replacement for the aging 3211 (it is backward compatible). The 4248 can operate at 3,600, 3,000, or 2,200 lines per minute and is priced at $99,000 for the basic model. The performance and pricing tend to confirm INPUT's past observations concerning printing systems (see Residual Value Forecasts for IBM Disk, Tape, and Printer Systems, March 1983 for detailed analysis of trends in printers). Essentially the points INPUT stressed in past publications were as follows:

  - IBM printing systems have evolved slowly and have not provided the price/performance improvement apparent in other peripheral categories.

  - IBM's general strategy has been to improve functionality while maintaining a relatively constant cost per unit of printed output.

- The 4248, as announced, has the following general characteristics:

  - Speeds can be changed through program control by the operator, and at 2,200 LPM optical recognition characters can be printed.

  - The 4248 can be expanded from 132 to 168 print positions permitting two 8-1/2-inch-wide sheets of paper to be printed side-by-side.

  - However, if the average of the adjustable speeds is used, the cost per rated line per minute of the 4248 is ~~practically~~ almost exactly that of the 3211 at announcement time ($34 for the 4248 versus $35 for the 3211).

  - More detailed analysis of the 4248 will appear in the mid-year update.

B. USED MARKET ACTIVITY

- Used market activity and prices are a major determining factor in the residual value of installed disk, tape, and printer products. The used market average retail prices for selected IBM equipment, as a percent of IBM list price, is presented in Exhibit III-3. It is important to understand the distinctions between the different prevailing price levels which are defined in this exhibit when considering the residual value forecasts ~~which will follow.~~ that

III-3

- General used market conditions are currently as follows:

  - 3380 disks continue to be in strong demand, but availability from IBM is also good (30-60 days), and trading in the secondary market is virtually non-existent except in cases where immediate delivery is required. There is, however, a purchase leaseback market for these devices through large brokers who take advantage of IBM's volume purchase discounts and offer slightly better arrangements than those currently available through IBM.

- 3350 disks are being actively traded in the used market with strong supply generated by excellent delivery schedules of 3380 replacements in large installations. Smaller installations recognize a bargain and are taking advantage of the attractive prices on 3350s. Even in large installations 3350s are highly cost effective for storing system software and smaller data sets which can take advantage of the smaller 3350 track size and minimize unused capacity.

- 3370 disks remain in strong demand and limited supply due to increased storage requirements on 4300 series processors.

- There is currently very little demand for 3375s in the used market because there are too many cost effective alternatives.

- The used market for 3420 tape drives varies significantly based on specific models.

  . Odd numbered models have an overabundance of supply with little trading.

  . Of the even numbered models, the 004 has only a limited market, but the demand for 006s and 008s remains strong with an especially active market in 008s.

- There is very little ~~market for~~ trading in 3800 printers because there is currently no replacement technology available to force used 3800s into the secondary market.

o Exhibit III-4 compares used market average retail prices in January 1984 against projections which were made in March 1983 (and in the case of the 3380 in November 1983). It should be remembered that where only limited markets exist, the "average retail price" for January 1984 may represent a spot trade. Even considering that, an explanation of the significant variances is useful.

- The retail prices for used 3350s are substantially lower than those projected a year ago (approximately 55% to 60% lower). As previously explained there is an active market for 3350s, but there is also a strong supply which has caused unanticipated price erosion in the used market. It is INPUT's opinion that the oversupply of 3350s is a direct result of the strong demand for on-line storage which was analyzed earlier in this report. Large users have had to convert to 3380s more rapidly than they anticipated because of heavy demand for on-line storage and have replaced 3350s (which were installed during the time when 3380s were in short supply) to provide that capacity and save floor space.

- On the other hand, retail prices of used 3380s are higher than anticipated because there is a limited used market (due to good IBM delivery schedules) and they only trade in the used market when requiring immediate delivery (as explained earlier).

- As far as tape drives are concerned, the limited market for odd-numbered models explains any variance, and the substantially higher used market prices for the even-numbered models is the direct result of IBM's failure to announce replacement technology (as discussed earlier).

- The projected printer prices for the 1403 and 3800 are quite accurate (as they should be), but the 3211 in a spot trade sold at substantially more than it has in recent years. (The announcement of the 4248 does not mean that the 3211 will be instantly obsoleted, for even at $30,000 it is a better price/performer.)

C. PROJECTED RESIDUAL VALUES

o Exhibit III-5 projects future average used-market retail values at January 1, 1985 through 1989 for selected disk, tape, and printer products. Exhibit III-6 projects these values as a percent of current IBM list price, and Exhibits III-7

III-5

through III-17 graph the range of anticipated values for the 1985 through 1989 timeframe.

- The adjustments in the projected residual values (from the residual value report of March 1983) are the result of used-market activity which was described earlier, list price adjustments which have occurred since that time, and continuing evaluation of technological trends.

- Projections are not given in this report for all members of the IBM 3350 and 3380 families. INPUT predicts residual values for other members of a given product family to be proportional to the ratio of the current list prices contained in Exhibit III-2. For example, the forecast residual value of the 3350 A2 (list price $32,030) in January 1986 is $3,800. The forecast value on the same date for the 3350 C2F (list price $41,070 from Exhibit III-2) would be:

$$\frac{\$41,070}{\$32,030} \times 3,800 = \$4,872$$

U-CLS

EXHIBIT II-1

DB2 GENERAL ARCHITECTURE

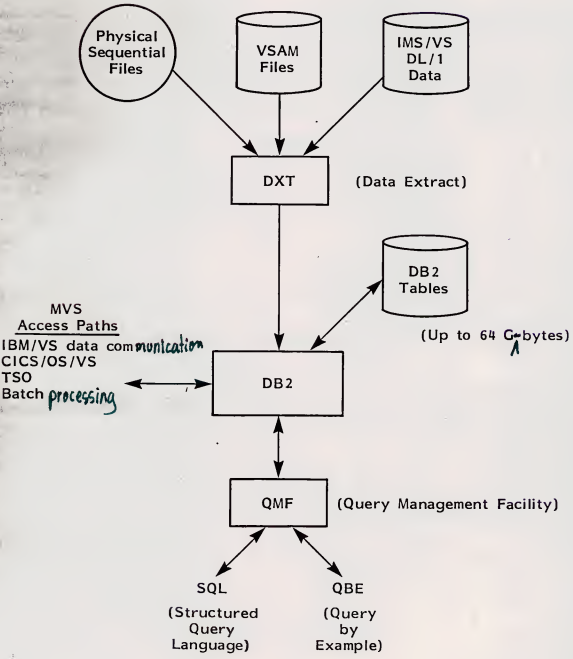

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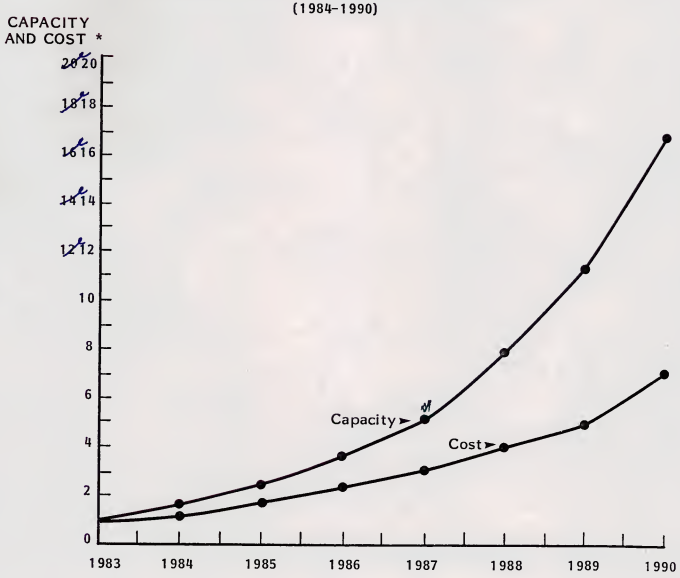
EXHIBIT II-3 2

INCREASED ON-LINE STORAGE CAPACITY AND COST
(1984-1990)



* 1983 = 1

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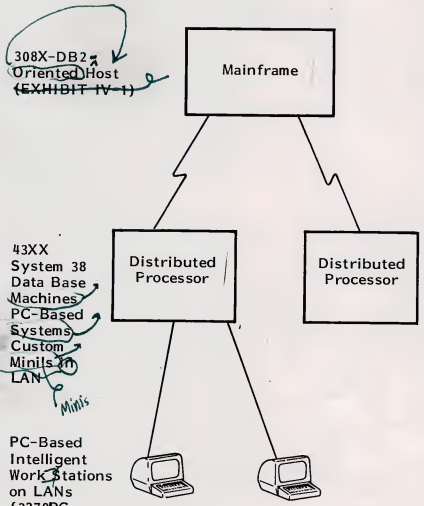
EXHIBIT II-13

PROJECTED STRUCTURE OF ~~DISTRIBUTERS~~ DISTRIBUTED DATA BASES



DATA BASES

1. Historical Data
2. Operating Data Bases
3. Corporate Planning Data Bases
4. Back Up for Notes

Backup

1. Extracts from Host Data Bases
2. Local Data Bases
3. Document Storage
4. ~~Back-Up~~ Backup for Personal Data Bases

1. Extracts from Host or Local Data Bases
2. Personal Data Bases

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EXHIBIT II-4

COST COMPARISON - OPTICAL MEMORIES VERSUS MAGNETIC DISK

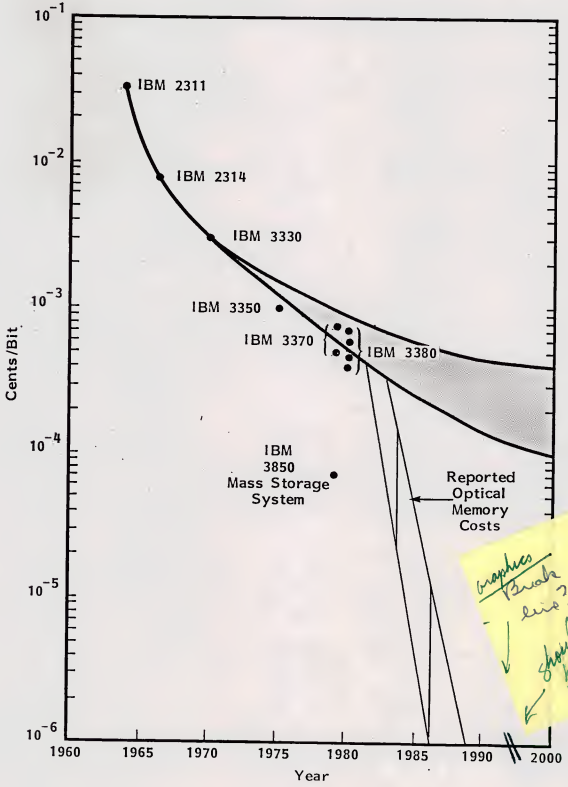

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EXHIBIT II-5

AVAILABILITY OF OPTICAL MEMORY SYSTEMS

GENERAL SYSTEM CATEGORY	AVAILABILITY				IBM	
	CURRENT	1984	1988	1990	PREFERRED	PREDICTED
1. Standalone Videodisk	X	-	-	-	1985	1984
2. Standalone Optical Disk	-	X	-	-	1985	1985
3. Electronic Filing and Retrieval (Local-Area Network)	-	X	-	-	1985	1985
4. Integrated Image Processing						
a. Basic System	-	X	-	-	1987	1986
b. Advanced System	-	-	X	-	1988	1988
5. Mainframe Optical Storage						
a. DRAW	-	X	-	-	1987	1986
b. Erasable	-	-	X	-	1990	1989
6. Distributed Information Manager	-	-	X	-	1988	1988
7. Network Store-and-Forward Reservoir	-	-	-	X	1990	1990

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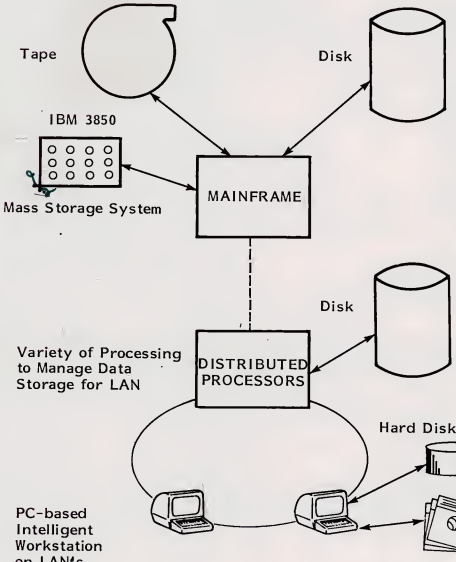
Graphics
Optimem

EXHIBIT II-6

AVAILABILITIES OF OPTICAL MEMORY SYSTEMS
IN THE ON-LINE STORAGE HIERARCHY



OPTICAL MEMORY SYSTEMS CATEGORY *

5a. 1984 STC
1986 IBM

5b. 1988 Someone
1989 IBM

6. 1988 Someone
1988 IBM

4a. 1984 Optimem
1986 IBM

4b. 1988 Someone
1988 IBM

1&2 Available now on custom basis

3. 1984 Optimum
1985 IBM

4a. 1984 Optimem (?)

* Categories defined in Exhibit II-5

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EXHIBIT III-1

PRICE TREND HISTORY FOR SELECTED IBM PERIPHERALS

TYPE OF EQUIPMENT	1964	1969-1971	1973 1975	1977 1979	1980 1981	1982	1983
Disks:							
3350-B02	-	-	49,500	31,680	-	32,940	25,360
3375-B01	-	-	-	-	32,550	33,850	28,770
3380-B04	-	-	-	-	81,000	84,240	71,600
Tapes:							
3420-003	-	13,580	12,420	14,340	-	14,910	11,930
3420-005	-	18,170	16,650	19,230	-	19,990	16,000
3420-007	-	22,380	20,520	21,540	-	22,400	17,920
3420-004	-	-	24,000	-	-	-	-
	-	-	21,960	23,050	18,440	19,170	15,340
3420-006	-	-	28,000	-	-	-	-
	-	-	25,650	26,130	21,540	22,390	17,920
3420-008	-	-	31,000	-	-	-	-
	-	-	24,440	29,860	23,890	24,840	19,880
Printers:							
1403N01	39,965	33,970	38,140	40,040	-	-	-
2821-2	27,100	23,040	25,900	27,190	-	-	-
3211	-	69,360	63,630	53,440	40,080	-	-
3811	-	30,600	28,080	23,580	17,685	-	-
3800-001	-	-	310,000	341,750	358,800	373,150	315,000

NOTE: Prices shown were the IBM list prices in effect at the end of the designated time period. The two figures shown for the 3420 models 4,6 and 8 are the list prices announced in the period reported.

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EXHIBIT III-2

LIST PURCHASE PRICE FOR IBM DISK PRODUCTS
(February 1984)

PRODUCT MODEL	PURCHASE PRICE ($)
3330-001	33,670
3333-001	42,200
3330-011	47,920
3333-011	56,540
3350-A02	32,030
3350-A2F	39,790
3350-B02	25,360
3350-B2F	33,300
3350-C02	33,130
3350-C2F	41,070
3370-A01	35,480
3370-A11	35,480
3370-B01	26,600
3370-B11	26,600
3375-A01	38,040
3375-B01	28,770
3375-D01	36,290
3380-A04	86,310
3380-AA4	98,640
3380-B04	71,600

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EXHIBIT III-3

USED MARKET AVERAGE RETAIL PRICES FOR SELECTED IBM EQUIPMENT
(As a Percent of IBM List)

MODEL	1982		1983			
	September	December	March	June	September	December
3330-001	6	3	3	3	2	1
3330-011	7	4	3	3	2	1
33350-A02	59	52	52	55	38	25
3350-B02	60	53	53	55	38	25
3380-AA4	104	103	101	101	93	93
3380-B04	105	103	101	101	93	93
3420-003	9	8	8	8	5	5
3420-005	11	10	10	10	9	9
3420-007	18	13	17	17	16	22
3420-004	52	55	55	57	59	53
3420-006	62	54	50	58	69	66
3420-008	80	69	67	71	86	86
1403-N01	8	7	5	4	3	3
3211-001	55	50	55	55	57	52
3803-001	63	63	63	60	58	58

The values shown are used market retail prices. At any given time, three price levels exist:

Retail Price - The amount an end-user would pay for the equipment.

Dealer Price - The amount a dealer would pay another dealer to acquire equipment to complete a contracted sales obligation.

Wholesale Price - The amount a dealer would pay to acquire equipment for resale.

The dollar spread between levels is a function of the total value of the transaction. For large processors the wholesale price will typically be 80% to 95% and for peripheral equipment 70% to 90% of the retail price.

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EXHIBIT III-4

COMPARISON OF USED MARKET AVERAGE RETAIL PRICES AGAINST PROJECTION
(January 1984 Against 1983 Projections)

EQUIPMENT TYPE	MODEL NUMBER	AVERAGE RETAIL PRICE	JANUARY 1984 RETAIL PRICES PROJECTED	
		JANUARY 1984	MARCH 1983	NOVEMBER 1983
Disk	3350-A02	8,000	14,100	-
	3350-B02	6,250	11,200	-
	3380-A04	80,250	67,300	77,700
	3380-B04	66,500	55,800	64,400
Tape*	3420-003	750	900	-
	3420-005	1,700	1,900	-
	3420-007	4,500	2,300	-
	3420-004	9,000	6,800	-
	3420-006	13,000	7,300	-
	3420-008	18,500	11,300	-
Printer	1403-N01	2,500	2,000	-
	3211-001	30,000	14,000	-
	3800-001	183,000	173,300	-

*Prices listed include feature 6631 (1600 BPI Density) for Models 003,005, and 007 and feature 6420 (6250 BPI Density for Models 004,006, and 008.

The dollar spread between retail ("buy") and wholesale ("sell") price levels depends upon the volume of the transaction. For the range of values shown above, the wholesale price will typically be 70% to 90% of the retail price.

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EXHIBIT III-5

RETAIL PRICES FOR SELECTED IBM PERIPHERALS
(Stated in Dollars)

EQUIPMENT TYPE	MODEL NUMBER	CURRENT LIST 1/1/84	PROJECTED USED MARKET RETAIL VALUE AT JANUARY 1 OF:				
			1985	1986	1987	1988	1989
Disk	3350-A02	32,030	$ 6,400	$ 3,800	$ 2,500	$ 1,600	$ 1,000
	3350-B02	25,360	4,600	2,250	1,500	700	250
	3380-A04	86,310	69,000	46,000	38,000	26,000	17,500
	3380-B04	71,600	57,250	38,000	31,500	21,500	14,500
Tape*	3420-003	14,800	$ 500	$ 300	$ 150	-	-
	3420-005	18,870	1,325	950	600	200	-
	3420-007	20,790	2,100	1,500	1,000	650	200
	3420-004	16,940	6,000	4,500	2,000	1,350	850
	3420-006	19,520	9,750	6,250	3,150	2,400	1,600
	3420-008	21,480	14,000	11,600	8,500	5,000	3,500
Printer	1403-No1	40,040	$ 1,200	$ 800	$ 400	-	-
	3211-001	40,080	22,000	15,000	10,000	4,000	1,200
	3800-001	315,000	164,000	140,000	95,000	57,000	35,000

*Prices listed include feature 6631 (1600BPI Density) for Models 003, 005, and 007 and feature 6420 (6250 BPI Density for Models 004, 006, and 008.

The dollar spread between retail ("buy") and wholesale ("sell") price levels depends upon the volume of the transaction. For the range of values shown above, the wholesale price will typically be 70% to 90% of the retail price.

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EXHIBIT III-6

RETAIL PRICES FOR SELECTED IBM PERIPHERALS

(Percent)

EQUIPMENT TYPE	MODEL NUMBER	CURRENT LIST 1/1/84	PROJECTED USED MARKET RETAIL VALUE AT JANUARY 1 OF:				
			1985	1986	1987	1988	1989
Disk	3350-A02	32,030	20%	12%	8%	5%	3%
	3350-B02	25,360	18	19	6	3	1
	3380-A04	86,310	80	53	44	30	20
	3380-B04	71,600	80	53	44	30	20
Tape*	3420-003	14,800	3%	2%	1%	–	–
	3420-005	18,870	7	5	3	1	–
	3420-007	20,790	10	7	5	3	1
	3420-004	16,940	35	26	12	8	5
	3420-006	19,520	50	32	16	12	8
	3420-008	21,480	65	54	40	23	16
Printer	1403-No1	40,040	3%	2%	1%	–	–
	3211-001	40,080	55	37	25	18	3
	3800-001	315,000	52	44	30	18	11

*Prices listed include feature 6631 (1600BPI Density) for Models 003, 005, and 007 and feature 6420 (6250 BPI Density for Models 004, 006, and 008.

The dollar spread between retail ("buy") and wholesale ("sell") price levels depends upon the volume of the transaction. For the range of values shown above, the wholesale price will typically be 70% to 90% of the retail price.

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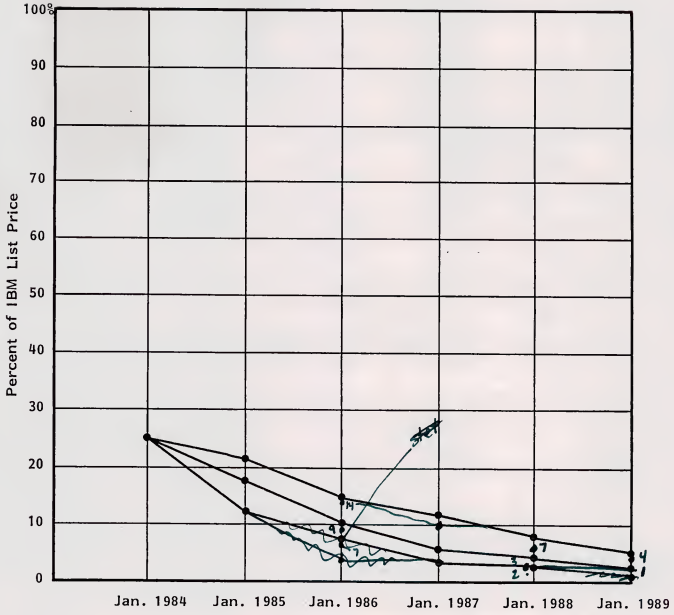
EXHIBIT III-7

RESIDUAL VALUE FORECAST FOR IBM 3350 DISK DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	22	14	10	7	4
Expected	18	9	6	3	1
Low	12	7	4	2	1

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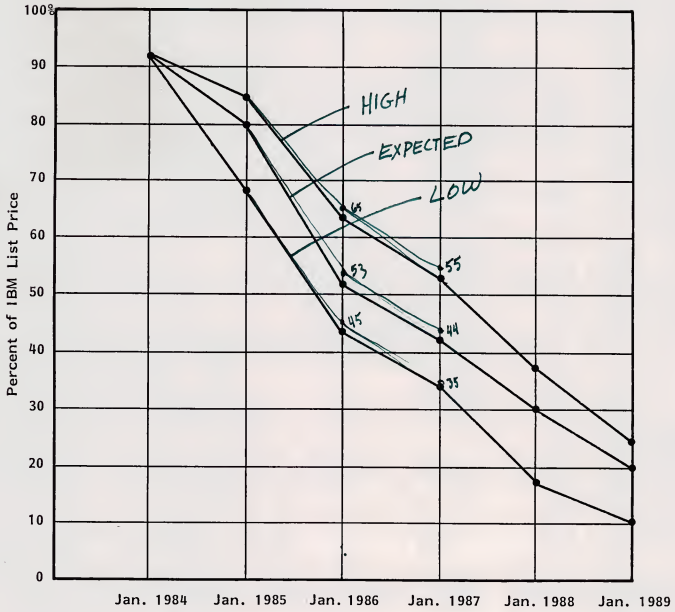
EXHIBIT III-8

RESIDUAL VALUE FORECAST FOR IBM 3380 DISK DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	85	65	55	38	25
Expected	80	53	44	30	20
Low	68	45	35	18	10

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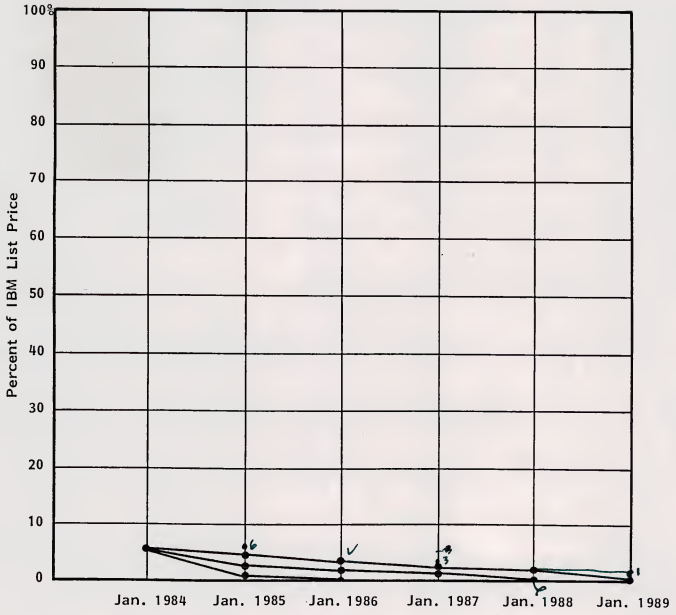
EXHIBIT III-9

RESIDUAL VALUE FORECAST FOR IBM 3420-003 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	6	4	3	2	1
Expected	3	2	1	–	–
Low	2	1	–	–	–

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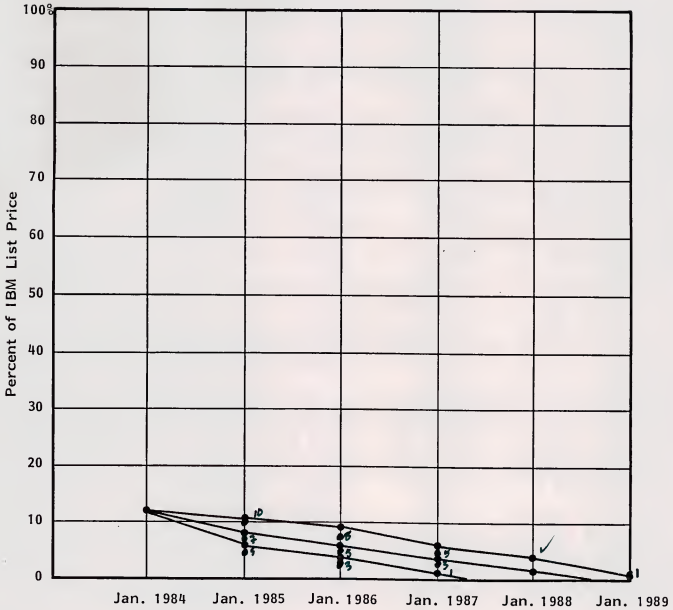
EXHIBIT III-10

RESIDUAL VALUE FORECAST FOR IBM 3420-005 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	10	8	5	3	1
Expected	7	5	3	1	–
Low	5	3	1	–	–

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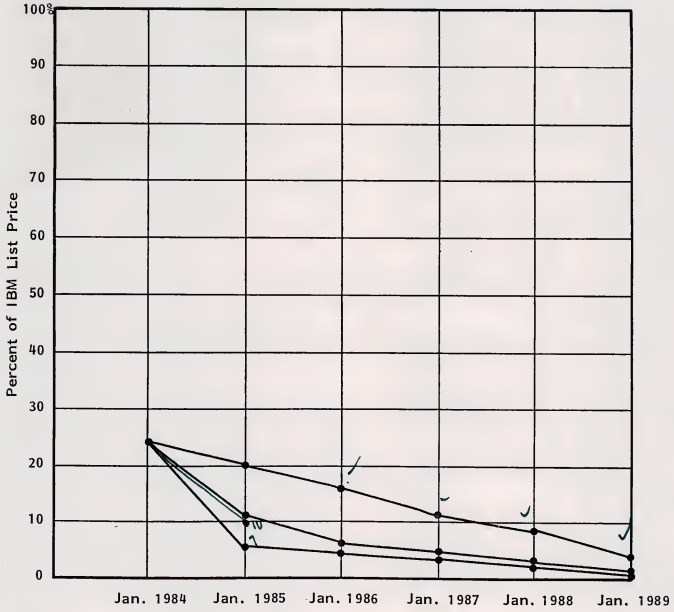
EXHIBIT III-11

RESIDUAL VALUE FORECAST FOR IBM 3420-007 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	20	16	11	8	4
Expected	10	7	5	3	2
Low	7	5	3	2	1

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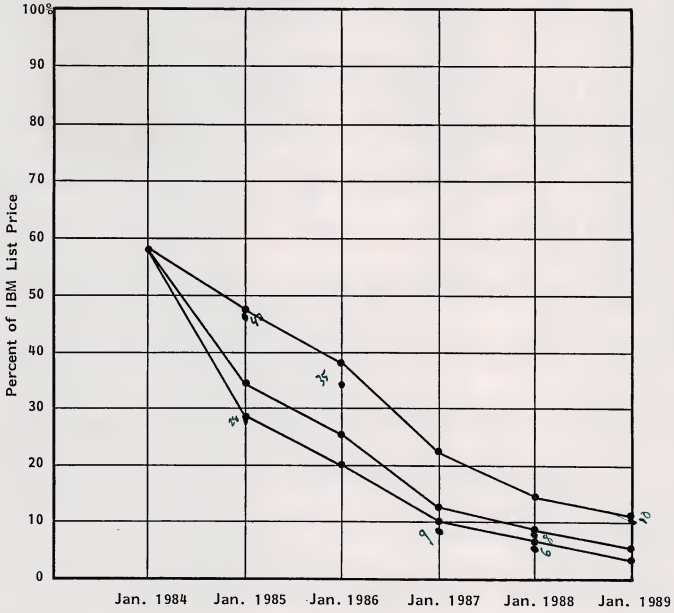
EXHIBIT III-12

RESIDUAL-VALUE FORECAST FOR IBM 3420-004 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	47	35	22	15	10
Expected	35	26	12	8	5
Low	28	20	9	6	3

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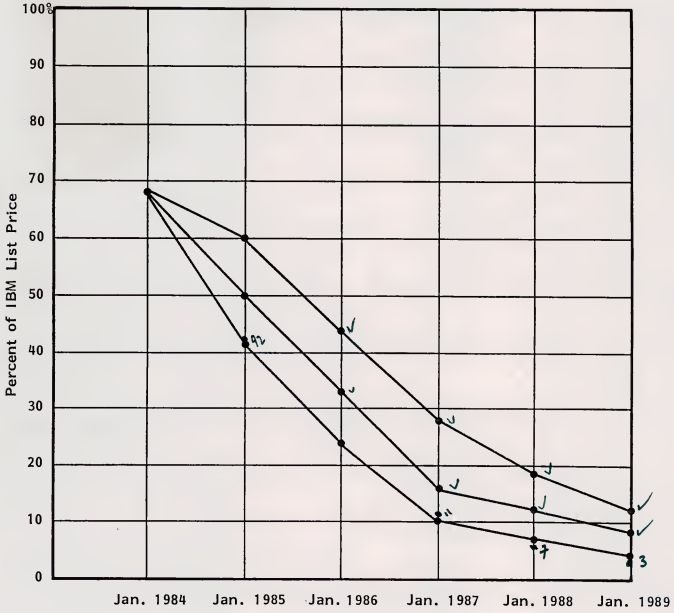
EXHIBIT III-13

RESIDUAL VALUE FORECAST FOR IBM 3420-006 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	60	44	28	18	12
Expected	50	32	16	12	8
Low	42	24	11	7	3

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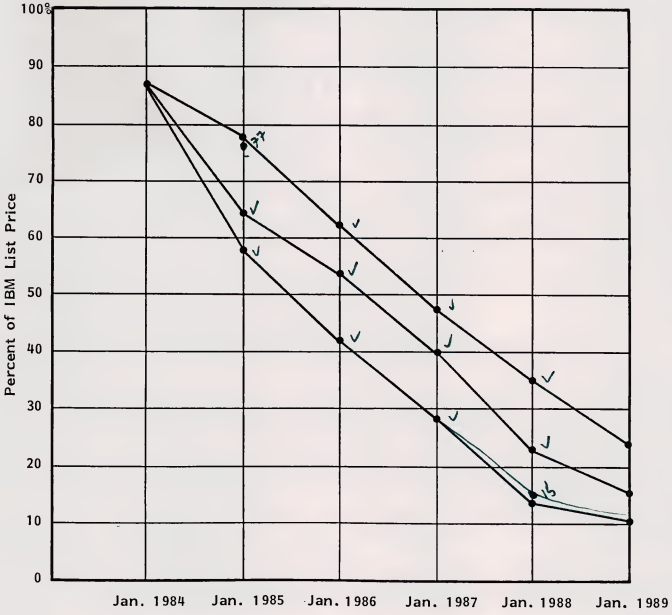
EXHIBIT III-14

RESIDUAL VALUE FORECAST FOR IBM 3420-008 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	77	62	48	35	24
Expected	65	54	40	23	16
Low	58	42	28	15	10

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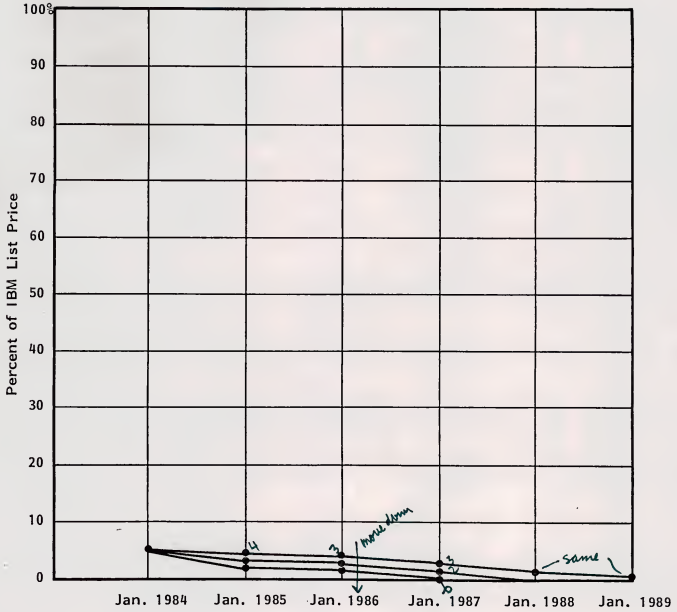
EXHIBIT III-15

RESIDUAL VALUE FORECAST FOR IBM 1403 PRINTER



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	4	3	2	1	1
Expected	3	2	1	–	–
Low	2	1	–	–	–

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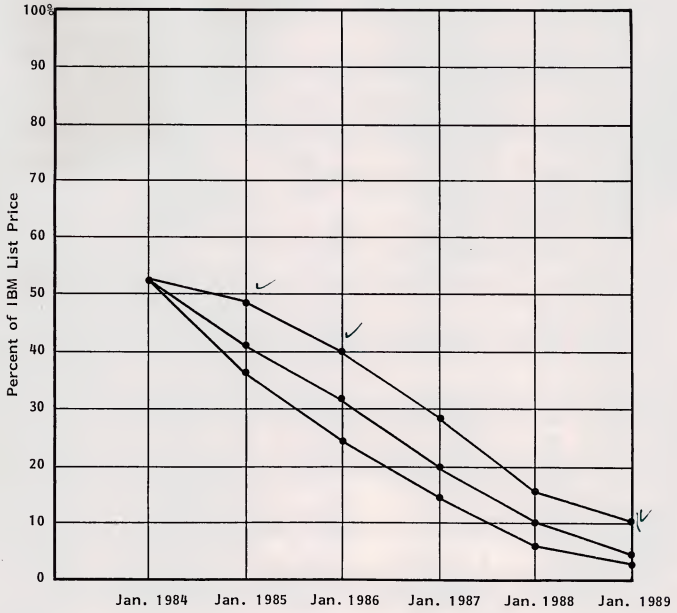
EXHIBIT III-16

RESIDUAL VALUE FORECAST FOR IBM 3211 PRINTER



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	48	40	28	16	10
Expected	41	32	20	10	3
Low	36	25	15	7	1

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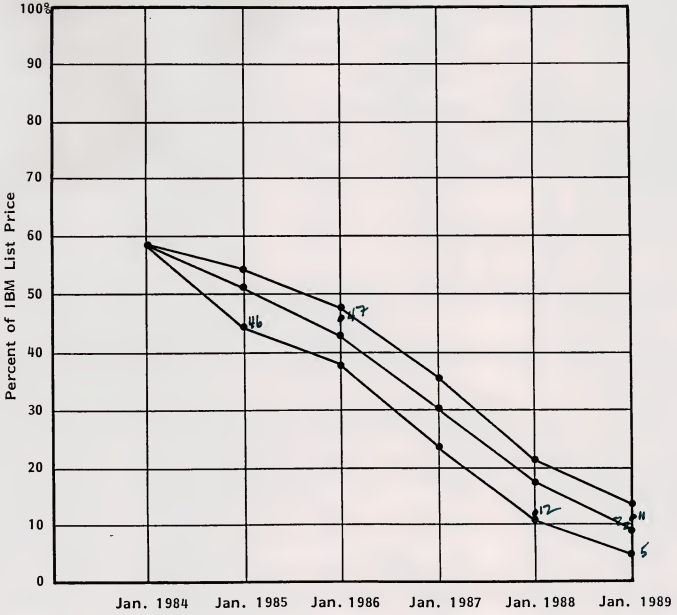
EXHIBIT III-17

RESIDUAL-VALUE FORECAST FOR IBM 3800 PRINTER



PROJECTED VALUES RANGE	JAN. 1985	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989
High	55	47	36	22	14
Expected	52	44	30	18	11
Low	46	38	24	12	5

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